# Short dental implants (6 mm) versus long dental implants (11-15 mm) in combination with sinus floor elevation procedures: 3-year results from a multicentre, randomized, controlled clinical trial

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Abstract: AIM: To test whether the use of short dental implants (6 mm) results in an implant survival rate similar to that with longer implants (11-15 mm) in combination with sinus grafting. METHODS: This multicentre study enrolled 101 patients with partial edentulism in the posterior maxilla and a remaining bone height of 5-7 mm. Included patients were randomly assigned to receive short implants (6 mm; GS/group short) or long implants (11-15 mm) simultaneously with sinus grafting (GG/group graft). Six months after implant placement (IP), implants were loaded with single crowns (PR) and patients were re-examined yearly thereafter. Assessed outcomes included: implant survival, marginal bone level changes (MBL), probing pocket depth (PPD), bleeding on probing (BoP) and plaque accumulation (PCR) during 3 years of loading as well as recording of any adverse effects. In addition to descriptive statistics, statistical analysis has been performed for the two treatment modalities using a non-parametric approach. RESULTS: In 101 patients, 137 implants were placed. At the 3-year follow-up (FU-3), 94 patients with 129 implants were re-examined. The implant survival rate was 100% in both groups. MBL at FU-3 was 0.45 mm (GG) and 0.44 mm (GS) ($p > 0.05$). A statistically significant loss of MBL was observed in both GG (-0.43 ± 0.58 mm) and GS (-0.44 ± 0.56 mm) from IP to FU-3, and from PR to FU-3 in GG (-0.25 ± 0.58 mm) but not in GS (-0.1 ± 0.54 mm). PCR and BoP at FU-3 did not show any difference between the groups but for PPD ($p = 0.035$). CONCLUSIONS: Within the limitations of this study, implants with a length of 6 mm as well as longer implants in combination with a lateral sinus lift may be considered as a treatment option provided a residual ridge height of 5-7 mm in the atrophied posterior maxilla is present.

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**Short dental implants (6 mm) versus long dental implants (11-15 mm) in combination with sinus floor elevation procedures: 3-year results from a multi-center, randomized, controlled clinical trial**

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Running title: short implants vs. sinus floor elevation procedures, 3-year results

Key words: dental implant, sinus floor elevation, sinus grafting, short dental implant, multicenter, randomized controlled clinical trial, posterior maxilla, single unit

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**Clinical relevance**

*Scientific rationale for the study*: At present, elevation of the sinus floor to increase the ridge height in combination with the placement of long dental implants is considered the gold standard in case of a limited ridge height in the posterior maxilla. In order to overcome limitations and drawbacks associated with this procedure, the use of short dental implants (≤ 8 mm) has been proposed to avoid extensive bone augmentation surgery.

*Principal findings:* Both treatment options, sinus floor elevation with long implants and short implants rendered similar outcomes at 3 years of function with respect to implant survival rates, peri-implant marginal bone levels, bleeding on probing and plaque measurements. Probing pocket depth revealed more favorable results for short implants as compared to longer implants.

*Practical implications:* Within the limitations of this study both treatment options can be recommended for the atrophied posterior maxilla with a residual ridge height of 5-7 mm.

**Abstract**

**Aim:** To test whether or not the use of short dental implants (6 mm) results in an implant survival rate similar to that with longer implants (11-15 mm) in combination with sinus grafting.

**Methods:** This multi-center study enrolled 101 patients with partial edentulism in the posterior maxilla and a remaining bone height of 5-7 mm. Included patients were randomly assigned to receive short implants (6 mm; GS / group short) or long implants (11-15 mm) simultaneously with sinus grafting (GG / group graft). Six months after implant placement (IP), implants were loaded with single crowns (PR) and patients were re-examined yearly thereafter. Assessed outcomes included: implant survival, marginal bone level changes (MBL), probing pocket depth (PPD), bleeding on probing (BoP) and plaque accumulation (PCR) during 3 years of loading as well as recording of any adverse effects. In addition to descriptive statistics, statistical analysis has been performed for the two treatment modalities using a non-parametric approach.

**Results:** In 101 patients, 137 implants were placed. At the 3-year follow-up (FU-3), 94 patients with 129 implants were re-examined. The implant survival rate was 100% in both groups. MBL at FU-3 was 0.45 mm (GG) and 0.44 mm (GS) ($p>.05$). A statistically significant loss of MBL was observed in both GG (-0.43mm±0.58mm) and GS (-0.44mm±0.56mm) from IP to FU-3, and from PR to FU-3 in GG (-0.25mm±0.58mm) but not in GS (-0.1mm±0.54mm). PCR and BoP at FU-3 did not show any difference between the groups but for PPD ($p=0.035$).

**Conclusions:** Within the limitations of this study implants with a length of 6 mm as well as longer implants in combination with a lateral sinus lift may be considered as a treatment option provided a residual ridge height of 5-7 mm in the atrophied posterior maxilla is present.

**Introduction:**

Short implants are frequently used in the posterior maxilla in order to avoid complementary surgical procedures. While some authors described a similar success rate with short implants as with those with a length of 10 mm and more (Rossi et al., 2015) (95% success rate after 5 years), other publications report an increased failure rate after 5 years with 6 mm implants versus those with a higher length (Rossi et al., 2016).

A recent meta-analysis on short implants versus standard implants in the posterior jaw including 13 studies with 1269 patients and 2631 implants showed no significant difference of implant survival, marginal bone loss, complications and prosthesis failure. Nevertheless, it was concluded, that short implants with less than 8 mm (4-7 mm) should be used with caution because they present higher risks of failure as compared to standard-length implants (Lemos et al., 2016).

Randomized, controlled clinical trials could not demonstrate any significant difference between 5-6 mm long implants and implants with standard length after crestal sinus lift (Felice et al., 2015) or lateral sinus lift procedure (Gulje et al., 2014). As a limiting fact, most of the patient populations studied were very small and they were only followed for rather short periods (Gulje et al., 2014, Gulje et al., 2015). However, in a systematic review based on the evaluation of 8 RCTs the EAO consensus conference 2015 noted that longer dental implants in the augmented sinus caused a higher number of biological complications, increased morbidity, costs and surgical time and therefore shorter dental implants may represent the preferred treatment alternative (Thoma et al., 2015b).

A Cochran analysis (Khouly and Veitz-Keenan, 2015) based on 4 trials was much more cautious with a definite statement: It was concluded that there is moderate quality evidence which is insufficient to determine whether sinus lift procedures in bone with residual height between 4 and 9 mm are more or less successful than placing short implants (5 to

8.5 mm) in reducing prosthesis or implant failure up to one year after loading. However, there were more complications at sites treated with sinus lift procedures.

Obviously there is a strong need for well-designed studies to provide more valid information on whether to use short implants in the posterior maxilla instead of a standard length implant in combination with a sinus lift procedure (Thoma et al., 2015b).

In a prospective, randomized multi-center study the 1-year results under masticatory loading for 6 mm implants were presented versus those for implants with a length of 10-15 mm in combination with a lateral sinus lift of the posterior maxilla (Schincaglia et al., 2015). The implants were restored using single non-splinted units. Implant survival rate was 100% in both treatment groups. However, short implants were more favorable regarding short-term patient morbidity, treatment time and price. Bleeding on probing (BoP) was higher in the group short as compared with the augmented group.

The present study evaluates and reports on the survival rate of 6 mm short implants compared with longer implants placed in sinus-grafted sites, after a follow-up period of 3 years.

**Material and methods**

A detailed description of patient demographics and 1-year results of this study was given earlier (Thoma et al., 2015a). Briefly, subjects with partial edentulism in the posterior maxilla, with a residual bone height of 5-7 mm and a ridge width of ≥ 6 mm and the presence of either natural teeth or a partial prosthesis or implants in the opposite jaw in contact with the planned crown/s were considered for the study. The reason for including patients even with a residual height of 5 mm was to also allow a cortical fixation of the short implants in case. Eligible participants were randomly assigned to receive either one of the following treatments: group short (GS), placement of 1-4 implants 6 mm in length and 4 mm in di-

ameter (ASTRA TECH Implant System OsseoSpeed$^{TM}$ 4.0S; Dentsply Sirona Implants, Mölndal, Sweden) or group graft (GG), placement of 1-4 implants 11, 13 or 15 mm in length and 4 mm in diameter (ASTRA TECH Implant System OsseoSpeed$^{TM}$ 4.0S; Dentsply Sirona Implants, Mölndal, Sweden) in combination with sinus grafting using a lateral window technique (Boyne and James, 1980). Preoperatively, patients were pre-medicated with antibiotics and subsequently rinsed with 0.2% chlorhexidine solution for one minute. The surgical procedure was performed under local anesthesia. Parenteral, oral or intravenous sedation was utilized upon the surgeon's preference. Randomization was done after flap elevation. The sinus was grafted using a xenograft (Bio-Oss$^{TM}$ Granules, Geistlich, Switzerland) that could be mixed with local bone chips collected during preparation of the lateral sinus approach (Safescraper Twist, CGM S.p.A., Divisione Medical Meta, Italy) on demand. All implants were left for transmucosal healing. In case of poor primary stability, as judged by the investigator, a conventional two-stage approach was used.

Five months after implant placement (IP), an impression of the implant(s) was made and a final restoration fabricated with non-splinted single-tooth crown(s) was done (PR). No restrictions were foreseen regarding the material and the type of retention (screw-retained or cemented). Patients were scheduled for a yearly follow-up thereafter.

Statistical analysis revealed no difference with regard to baseline characteristics such as sex, age, abnormal jaw conditions, periodontitis, bruxism, smoking habits, bone quantity and quality between the two groups (Thoma et al., 2015a).

*Primary and secondary outcome variables*

The main response variable was the cumulative implant survival rate (CSR). Secondary outcome variables included: probing pocket depth (PPD), bleeding on probing (BoP), plaque control record (PCR), marginal bone level (MBL) and adverse events (AE).

*Implant Survival*

Any implants removed after implant placement were considered as failures. Patient implants were considered as lost to follow-up, if the patients did not attend the scheduled visit; hence missing values were estimated assuming “not lost” and considered as censored in the same way as one patient’s death.

*Clinical measurements*

PPD and BoP were assessed at four aspects per implant (mesial, distal, buccal and palatal) by using a periodontal probe. PPD was measured as the distance from the mucosal margin to the bottom of the probable pocket in mm. BoP was recorded as presence or absence of bleeding when probing to the bottom of the pocket. The level of oral hygiene was evaluated using the Plaque Control Record (PCR) (O'Leary et al., 1972). Plaque on the four surfaces of each investigated implant was recorded as being present or not.

*Marginal bone level alteration*

Periapical radiographs using the paralleling technique were taken at IP, at PR, and yearly thereafter. MBL was determined based on radiographs and expressed as the distance from the implant shoulder to the most coronal bone-to-implant contact on the mesial and distal side of the implant. An independent examiner performed all radiographic measurements. The mean values were calculated for each implant. The change in MBL from implant placement (IP) to the year-3 follow-up (FU-3) and from PR to FU-3 was calculated [Δ (IP- FU-3) and Δ (PR - FU-3)], respectively.

*Statistical analysis*

The statistical software used was IBM SPSS (IBM Corp., Armonk, NY) and Excel (Microsoft, Redmond, WA, USA). A non-parametric statistical approach was applied. For continuous data the Wilcoxon Rank Sum test (exact) was used to compare treatment groups (GG vs GS), Wilcoxon Signed Rank test (exact) was used to compare changes within each treatment group and Fisher's exact test for nominal data. Nominal data were also presented using descriptive statistics. A P-value below 0.05 was considered as statistically significant. No adjustment for multiplicity was applied.

## Results

Details on demographics, patient-reported outcome measures, surgical time and costs as well as the influence of the significant difference in crown-to-implant ratio (C/I was 0.99 ±0.17 and 1.86 ± 0.23 for GG and GS, respectively) in terms of short observation period were already reported earlier (Schincaglia et al., 2015, Thoma et al., 2015a).

In total, 101 patients with 137 implants entered the clinical trial. Thirty-eight implants (19 GS and 19 GG, respectively) were allowed to heal submerged, whereas a one-stage approach was chosen for 99 implants (48 GS and 51 GG, respectively). One patient (GS) died due to previously unknown blood cancer during the time between implantation and crown placement with the implants still in place. Ninety-four patients (45 patients GS, 49 patients GG) with 129 implants (61 implants GS, 68 implants GG) were available for re-evaluation at the 3-year follow-up (FU-3) (Fig. 1).

### *Implant survival*

All 129 implants in 94 patients examined at FU-3 were clinically stable with no signs of peri-implant inflammation, thereby providing for a 100% CSR.

*Clinical measurements*

At FU-3, PPD measurements revealed significantly less PPD for GS (2.8±0.9 mm) as compared to GG (3.0±0.76 mm) (p=0.035). The mean increase in PPD between FU-1 (2.5±1.1 mm and 2.7±0.9 mm for GG and GS, respectively) and FU-3 was not statistically significant for GS (0.1 mm ±1.1 mm; p=0.646), but for GG (0.5 mm ±1.1 mm; p= 0.001).

No statistically significant differences were observed for PCR recorded at FU-1 (GG 6.3%; GS 12.7% of implant surfaces; p=0.098) as well as FU-3 (GG 5.2%; GS 11.1%; p=0.262) between GG and GS. However, BoP recorded at FU-1 showed a statistically significant difference with a higher number of sites with BoP positive for GS (p=0.034) (GG 15.4%; GS 22.1% of implant surfaces). At the FU-3 the overall number of surfaces with positive BoP was 20.1% for the GS and 30.9% for GG (p=0.380).

*Marginal bone level alterations (MBL)*

MBLs of implants in the GG and GS groups are presented in Table 1. No statistically significant difference could be observed between the groups at the different observation periods. Radiographs of 52 and 50 implants were available in the GG and the GS, respectively, for the measurement of Δ (IP- FU-3) and Δ (PR— FU-3). A statistically significant loss of marginal bone was observed in both GG and GS from IP to FU-3, and from PR to FU-3 in GG, but not in GS. There was no statistically significant difference between the two groups for the measurements of Δ (IP- FU-3) and Δ (PR - FU-3), respectively (Table 2). Cumulative representation of MBL distribution from IP to FU-3 and from PR to FU-3 has been shown in Fig.2 and 3, respectively.

Upon separate analysis of the MBL for the two groups by premolar and molar region, no significant difference could be seen at any of the time points: At the FU-3 the MBL in the

premolar region was 0.4 ± 0.6 mm for GG and 0.6 ± 0.7 mm for GS (p= 0.568), while the MBL in the molar region revealed 0.5 ± 0.5 mm for GG and 0.4 ± 0.5 mm for GS (p=0.466). The development from IP to FU-3 and PR to FU-3, respectively, did not differ significantly either (Table 3).

*Adverse events (AEs)*

For the time from FU-1 to FU-3 no biological complications were recorded but an overall 13 AEs were observed (Tab. 4) showing no significant difference between the groups (p = 0.654). Most AEs (n=10) involved a loosening or a fracture of the abutment screw and mainly concerned implants placed in the molar region but did not reach a statistical significance between the molar and premolar region (p=0.278).

**Discussion:**

The present investigation reports on the 3-year results of a prospective, randomized, multi-center study assessing the value of short implants in the posterior maxilla. The implants were placed in the region between the first premolar and the second molar and all implants, including neighboring ones, were restored with single-tooth, non-splinted crowns. This was done in contrast to other prospective, randomized studies on the value of short implants (Felice et al., 2012, Esposito et al., 2015) for assessing a potential impact of masticatory loading on the implants.

Furthermore and in contrast to other studies (Esposito et al., 2011, Pistilli et al., 2013a, Gulje et al., 2014, Nedir et al., 2016) short implants were placed in pristine bone in order to provide answers to the question, if short implants may substitute longer implants that may only be placed in conjunction with a sinus lift procedure.

According to other RCTs (Fan et al., 2016) and to allow a comparison of the results of GS vs. GG a healing period of 6 months prior to loading was allowed for the GG as well as the GS.

Six patients (4 GS and 2 GG) could not be examined at the 3-year follow up, resulting in a dropout rate of 6 % (GS 8%, GG 4%), which is comparable to that found with other RCTs and CCTs for shorter observation periods (Esposito et al., 2011, Esposito et al., 2012, Pistilli et al., 2013a, Gulje et al., 2014, Nedir et al., 2016).

During the three-year follow-up no implant failed resulting in a 100% implant survival for both groups investigated. This is consistent with the implant survival rates reported for randomized controlled trials (RCT) and controlled clinical trials (CCT) that ranged between 97% and 100% after mean observation periods of 8–18 months (Esposito et al., 2011, Pistilli et al., 2013a, Pistilli et al., 2013b, Gulje et al., 2014, Thoma et al., 2015a), but markedly better than in a recently published RCT after 5 years of function (Rossi et al., 2016). It is also better than the survival rates of 80% to 90% recently reported for implants ≤ 7 mm in a systematic review (Karthikeyan et al., 2012). Strikingly, implant losses with short implants were predominantly reported during the healing phase, prior to prosthetic loading (Atieh et al., 2012), or in the early phase (Srinivasan et al., 2014), but rarely during the continued function of the implants (Perelli et al., 2012). In this prospective, 3-year, multicenter study, no implant losses were seen either in GS or in GG. As a possible explanation for diverging results, it may be noted that strict selection criteria need to be fulfilled in a prospective, randomized study, while such criteria may not be considered to the same extent in normal daily practice. In spite of reports to the contrary (Srinivasan et al., 2014), the use of short implants upon strict indication may obviously be associated with favorable results even in the maxilla. Our results also show that for up to 3 years of loading short implants show a survival being not different from that of implants with a length between 10

and 15 mm having been placed in conjunction with a lateral sinus lift procedure but involve significantly less postoperative impairment for the patient (Thoma et al., 2015a). The results confirm those of a recently published meta-analysis (Fan et al., 2016) of 7 RCTs with 554 implants (265 implants in the short group with a length of 5 to 8 mm) in the atrophic posterior maxilla, and of systematic reviews (Atieh et al., 2012) covering 2573 short implants published in 33 articles (5 randomized clinical studies; 16 prospective, non-randomized, non-controlled studies; 12 retrospective, non-randomized studies; and 1 study with both prospective and retrospective data) with a follow-up period of 1 year for most of the implants.

The study design allowed implant healing with a transmucosal abutment (1-stage) or submerged (2-stage). The effect of 1-stage versus 2-stage approach on soft tissue and hard tissue remodeling had been investigated previously on animal and clinical studies (Collaert and De Bruyn, 1998) (Abrahamsson et al., 1999) and no difference was reported when comparing the two procedures. As regards the peri-implant parameters recorded, PPD measurements at FU-3 were significantly lower in GS (2.8±0.9 mm) versus GG (3.0±0.76) in contrast to the measurements at FU-1(Schincaglia et al., 2015) and the increase of PPD during the time from FU-1 to FU-3 was statistically significant for GG, but not for GS. Overall, PPD in both groups was acceptable for successful implants. It remains to be seen whether the difference measured will also be clinically relevant.

Throughout the complete follow-up period of 3 years the PCR in GS was invariably slightly increased versus that in GS (11.1% vs. 5.2% at FU-3), though this difference never reached the level of significance. The significantly worse BoP measured for implants of GS at FU-1(Schincaglia et al., 2015) was no longer detectable at FU-3 (20.1% for GS; 30.9% for GG). The generally favorable results of the clinical measurements are consistent with

those reported by others (Canullo et al., 2009). It remains to be seen whether the differences measured will also be observed over longer periods.

A statistically significant loss of mean marginal bone was observed in both GG (- 0.43 mm) and GS (- 0.44 mm) from IP to FU-3, and from PR to FU-3 in GG (-0.25 mm) but not in GS (-0.1 mm). Thus, the overall loss of MBL after 3 years of observation was less than that seen in other RCTs at 12 months after loading (Pistilli et al., 2013a, Pistilli et al., 2013b). Thirty-six months after prosthetic restoration no significant difference could be found between the two groups which is consistent with other studies and shorter follow-up periods (Felice et al., 2015).

About 60% of the implants showed a loss of MBL between IP and FU-3. Between PR and FU-3 roughly 40 % of implants in GG and 30% of those in GS showed a loss of MBL but in 20% of both groups a gain in MBL could be seen (Fig. 2 and 3). This has not yet been described in any other RCT. It seems that the surgical trauma with flap elevation has a somewhat negative impact on bone level (GG more than GS) as has also been shown for immediate implant placement in conjunction with flap elevation(Favero et al., 2015). In the course of time regeneration of the peri-implant bone could be seen in about 20% of implants in both groups. It needs to be seen, whether this trend will continue with prolonged placement time of the implants.

Generally it showed that all AEs observed during the three years of implant function were prosthetic-related (loosening or fracture of the abutment screw as well as loosening of crowns). Fractures or loosening of abutment screws were mostly seen in implants for the replacement of molars, but only once in the premolar region, though the difference failed to reach the level of significance. These AEs may be due to various reasons: In the present study, the implants were restored with single-unit, non-splinted crowns. Finite element (FE) studies have shown that interlocking of neighboring implants will reduce the stress load,

especially at the interior region of the abutment (Toniollo et al., 2016). Moreover, the masticatory load in the molar region is significantly higher than that in the region of the premolars (Mericske-Stern et al., 2000, Zhao et al., 2016) and the mesio-distal diameter of the molar crown is larger than that of a premolar crown. Taken alone, this would already result in a higher rotational load on the implant and the implant-abutment connection during mastication. In addition, if the implant has not been centrally placed in the axis of the premolar/molar, the effective torque will be multiplied. The extent to which this has been the case in the present study could not be determined, as the three-dimensional position of the implant to the occlusal plane has not been evaluated. However, the higher masticatory load in the region of the molars did not have any impact on MBL and even at FU-3 no differences between premolars and molars could be detected. The fact that mechanical load after successful osseointegration primarily affects the implant-abutment connection and not the bone-implant complex would also be confirmed by those investigations assessed in the context of FE studies (Georgiopoulos et al., 2007). The present study used implants with a conical and a dual internal hexagon connection and not the implants of the same company that were marketed as further development with a 6 + 1/ one and only connection (Astra Tech Implant System$^{TM}$ EV, Dentsply Sirona Implants, Mölndal, Sweden). Thus, no answers can be given regarding the situation evolving with the new implant geometry and single-crown restorations in the posterior maxilla.

Overall, the results reported for short implants after 3 years in function are highly promising and equivalent to those for normal-length implants having been placed in combination with a sinus lift. However, the expected long-term results must be considered before establishing a final assessment.

**Conclusion:**

Within the limits of the relatively short observation period, the results of this prospective randomized multi-center study suggest short implants (6 mm) for implantologic single-tooth restorations in the posterior maxilla as a viable solution versus longer implants in combination with sinus lift. Further long-term studies will be required to confirm these findings.

**Acknowledgments and conflicts of interest**

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| | IP | PR | FU-3 |
|---|---|---|---|
| | GS | | |
| ***Mean (SD)*** | 0.03 (0.15) | 0.30 (0.45) | 0.44 (0.44) |
| ***n. of implants*** | n = 60 | n = 55 | n = 58 |
| | GG | | |
| ***Mean (SD)*** | 0.06 (0.20) | 0.27 (0.45) | 0.45 (0.55) |
| ***n. of implants*** | n = 58 | n = 56 | n = 63 |
| ***P-value*** | 0.199 | 0.497 | 0.816 |

*Table 1: Marginal bone level alteration in mm and standard deviation (SD): Intra group and between group analysis. IP: implant placement; PR: prosthetic reconstruction; FU-3: follow-up year 3; GS: group short; GG: group graft*

| Δ (IP- FU-3) | | | |
|---|---|---|---|
| | *GS* | *GG* | *P-value* |
| ***Mean (SD)*** | -0.44 (0.56) | -0.43 (0.58) | 0.974 |
| ***n. of implants*** | n = 52 | n = 52 | |
| ***P-value*** | 0.000 | 0.000 | |
| **Δ (PR - FU-3)** | | | |
| | *GS* | *GG* | *P-value* |
| ***Mean (SD)*** | -0.10 (0.54) | -0.25 (0.58) | 0.110 |
| ***n. of implants*** | n = 50 | n = 50 | |
| ***P-value*** | 0.636 | 0.004 | |

*Table 2: Distribution of marginal bone level alteration between groups from implant placement (IP) to the 3-year follow-up (FU-3) and from the prosthetic reconstruction (PR) to FU-3. GS: group short; GG: group graft*

| Δ (IP- FU-3) | | | | | | |
|---|---|---|---|---|---|---|
| | *PM* | | | *Mol* | | |
| | GS | GG | P-value | GS | GG | P-value |
| ***Mean (SD)*** | -0.59 (0.72) | -0.36 (0.63) | 0.440 | -0.36 (0.46) | -0.47 (0.57) | 0.470 |
| ***n. of implants*** | n = 18 | n = 17 | | n = 34 | n = 35 | |
| **Δ PR - FU-3)** | | | | | | |
| | *PM* | | | *Mol* | | |
| | GS | GG | P-value | GS | GG | P-value |
| ***Mean (SD)*** | -0.19 (0.69) | -0.18 (0.65) | 0.785 | -0.05 (0.45) | -0.28 (0.56) | 0.058 |
| ***n. of implants*** | n = 17 | n = 15 | | n = 33 | n = 35 | |

*Table 3: Distribution of marginal bone level alteration between groups from implant placement (IP) to the 3-year follow-up (FU-3) and from the prosthetic reconstruction (PR) to FU-3 separately for premolar (PM) and molar (Mol) region and groups. GS: group short; GG: group graft*

| | GS | | GG | |
|---|---|---|---|---|
| | *ASL / AF* | *DC* | *ASL / AF* | *DC* |
| ***FU-2*** | 7 | 1 | 1 | 0 |
| ***FU-3*** | 1 | 0 | 1 | 1 |
| ***Total*** | 8 | 2 | 2 | 1 |

*Table 4: Distribution of adverse events (AEs) of group short (GS) and group graft (GG) according to the observation periods; FU-2: follow-up year 2; FU-3: follow-up year 3; ASL: loosening of abutment screw ; AF: fracture of abutment screw; DC: decementation of crown.*

Figure 1

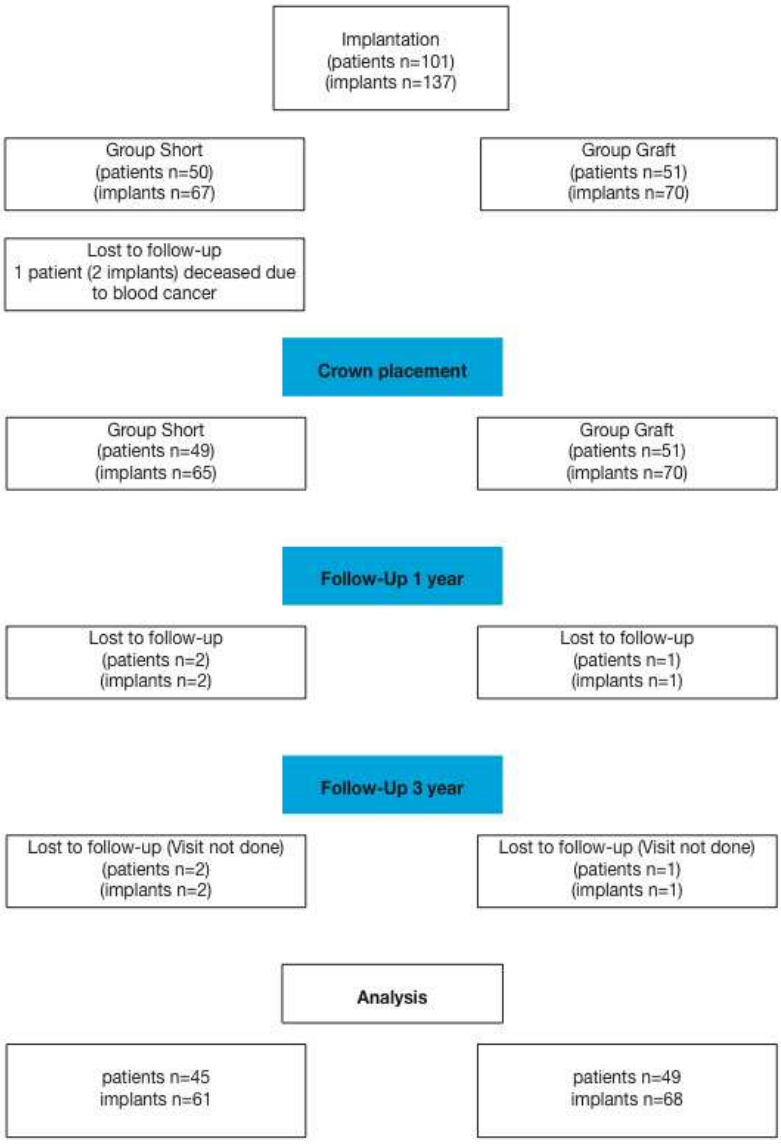
Implantation
(patients n=101)
(implants n=137)
Group Short
(patients n=50)
(implants n=67)
Group Graft
(patients n=51)
(implants n=70)
Lost to follow-up
1 patient (2 implants) deceased due to blood cancer
Crown placement
Group Short
(patients n=49)
(implants n=65)
Group Graft
(patients n=51)
(implants n=70)
Follow-Up 1 year
Lost to follow-up
(patients n=2)
(implants n=2)
Lost to follow-up
(patients n=1)
(implants n=1)
Follow-Up 3 year
Lost to follow-up (Visit not done)
(patients n=2)
(implants n=2)
Lost to follow-up (Visit not done)
(patients n=1)
(implants n=1)
Analysis
patients n=45
implants n=61
patients n=49
implants n=68

Figure 2

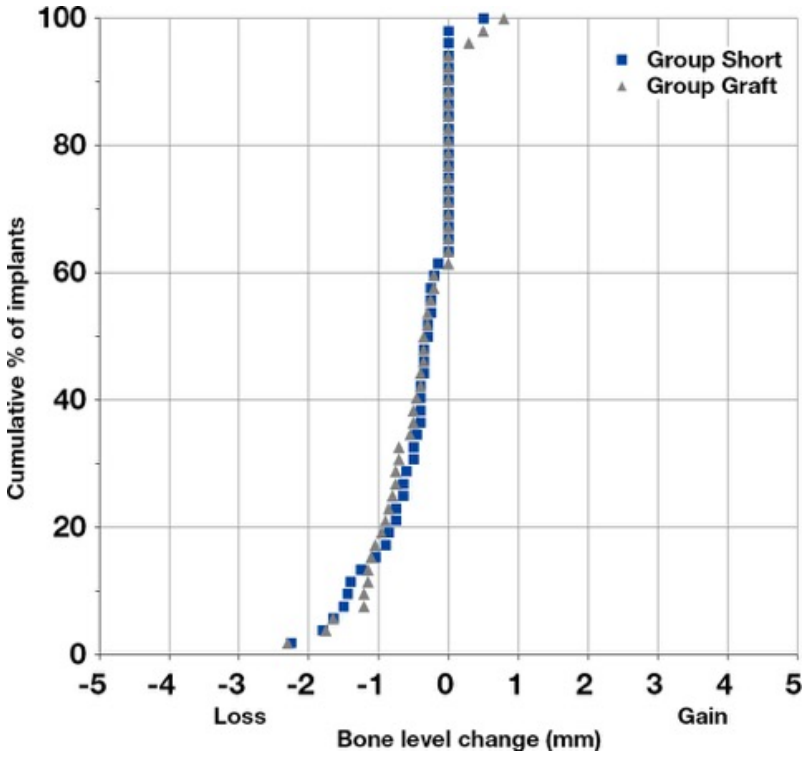


Figure 3